Result Page

< Desc/Clms PAGE NUMBER 1>

Measuring device and method for measuring an operating point of tools for industrial robot the invention relates to a measuring device for measuring an acre of point of pickling of tools for industrial robots as well as a method for measuring operating point of tools for industrial robots with such a measuring device.

Industrial robots have several connected with one another arms, a hand flange at the end of the last arm of the chained with one another arms, and a work things, for starting arbitrary points within an acre of pickling area which is mounted to the hand flange. The tool can be with a spielsweise gripper, a welding head or similar.

The attitude and orientation of the hand flange or the operating point egg of nes tool mounted to the hand flange can take place in a stationary robot-independent absolute Cartesian coordinate system or a stationary Basiskoordina tensystem based on one point of anchorage of the industrial robot. The description of the attitude of the degrees of freedom, D. h. the axes and hand orientation made however in robot coordinates, whereby on the basis of the basic axle of the robot, D. h. the Basiskoordi natensystems, for each arm an axle robot coordinate system defi is niert, which describes the relative position of each axis related to its proceeding axis. The connection of the axle of robot coordinate systems of an industrial robot becomes described by defined Koordinatentransformationen. By default of the attitude and that

< Desc/Clms PAGE NUMBER 2>

Orientation hand flange or the operating point of the tool in the absolute Cartesian coordinate system thus the axle robot coordinates calculated can become, in order to be able to head for the individual axes of the industrial robot by Koordinatentransformation.

The attitude of an operating point of a tool, which becomes mounted to the hand flange of the industrial robot, becomes by so called TCP position coordinates described. The programming of the industrial robot made on the basis of the hand flange and the fixed TCP position coordinates. The TCP position coordinates are provided with each tool and are known as Tool center POINT (TCP). The TCP position coordinates is just like the axle robot coordinates in each case a vector with six dimensions. The first three coordinates define the attitude of the operating point relative to the point of tool basis of the Indu of stringer robot, D. h. the fastening spot of the tool at the hand flange. The other three coordinates define the orientation of the oh sen the operating point relative to the point of tool basis.

The working point of the tool can be for example the tip of a welding head. Only if the TCP position coordinates are exact known, can be proceeded the working point of the tool precise.

In the operation itself the working point of the tool can however by work things wear, deflection etc. change, which leads to an incorrect Positio nierung the operating point of the tool.

It exists to measure therefore the need the working point of tools highly exact.

< Desc/Clms PAGE NUMBER 3>

In the EP 0,417,320 A1 a method is for measuring the Arbeitspunk width unit (TCP) of the tool of an industrial robot described, is fixed with which a set point at the hand flange of the robot arm, whereby the position of the driving point is relative known to the hand flange.

Further a reference point is in the work space of the industrial robot up provided. Measuring the operating point the tip of the tool becomes on the reference point fitted and the position and orientation of the tool tip in a basis coordinate system certain. Then the set point of the hand flange becomes on the reference point fitted and the position and orientation of the driving point in the coordinate system of the hand flange certain. Besides the position and orientation of the reference point in three-dimensional axes certain and from the three female moulds become transformation matrix the designation of the TCP position coordinates of the operating point of the tool calculated.

Measuring requires a multistage procedure procedure as well as Koor dinatentransformationen.

From the US patent 6.352, 354 B1 is a light spot element to the generation of a light spot signal at a working point of a robot of tool described. Thereby the precise position of the tool can become during a learning phase described.

In the US patent 5.929, 584 is a method for measuring an acre of point of pickling of tools with a calibration block described, which has vertical and horizontal surfaces. By movement of the tool from a start position to a contact point of the tool at one of the surfaces and going back the tool to the starting point and again the procedure for the other surface become the TCP position coordinates of the operating point get calculated. For this is a disadvantageous aufwändige Koor

< Desc/ Clms PAGE NUMBER 4>

dinatentransformation of three-dimensional axes over the single robot coordinates up to the hand flange required nen, in order to determine from the reference coordinates the TCP position coordinates in the TCP coordinate system.

Object of the invention was it to create an improved measuring device for measuring an operating point of tools for industrial robots as well as a method for this in order to be able to measure in the operation precise and the rapid working point of tools.

The object becomes with the genericin accordance with-eaten measuring device erfin dung in accordance with by the fact dissolved that the measuring device has several itself light barriers crossing in a reference crossing point.

In contrast to the conventional calibration blocks with horizontal and vertical surfaces such a measuring device with fork light barriers can become relative small and easy constructed and fixed in the work space of the industrial robot mounted. In the operation the working point of the tool, the tool tip, can into the reference crossing point of the light barriers be usually driven, in order to measure the TCP position coordinates (Tool center POINT ZKP) new.

For this the light barrier measuring instrument has preferably a frame with two from each other spaced parallel legs, open on a side. At least in the region of the front and rear end of the legs in each case a transmitter and a receiver for light barriers aligned between the legs to the frame are provided. The tool can thus into this u-shaped measuring device be in-driven and so prolonged be proceeded there, to the working point, D. h. the tool tip of the tool the reference crossing point passed and both light

< Desc/ Clms PAGE NUMBER 5>

barriers interrupted are and therefore a switch signal deliver.

Then the TCP position coordinates become determined.

The light barriers are preferably ausge as infra-red light barriers lead.

Measuring the operating point made preferably with the steps: a) Specify the TCP position coordinates of the operating point of the work zeuges related to one point of tool basis of the industrial robot and a TCP coordinate system based on the working point, b) to methods of the tool with reference to the TCP
Coordinate system so long, until the working point of the tool lies in the reference crossing point of the light barrier measuring instrument, C) correcting the TCP position coordinates around the difference between the fixed TCP position coordinates and with the method of the work of zeuges regarding the TCP coordinate system more immediate in the TCP Coordinate system present attitude of the operating point in the RH ferenz crossing point.

Proposed, the tool will thus proceed according to invention regarding the TCP coordinate system to, D. h. the control made not like conventional on the basis of the absolute Cartesian coordinate system or Basisko of ordinate system of the industrial robot, but more immediate with reference to TCP coordinate system. The TCP coordinate system has usually being nen origin in the point of work, for example the probe tip of the work

< Desc/ Clms PAGE NUMBER 6>

top

things, and an orientation toward the point of tool basis, with spielsweise of the fastening spot of the tool at the hand flange.

In this way achieved becomes that the control controlling of the Industriero is boters immediate based on the TCP coordinate system and can without other transformations the displacement of the operating point relative the before specified TCP position coordinates of the operating point certain become. It becomes thus the displacement reference crossing of the point related to the origin of the TCP coordinate system certain, whereby the origin of the TCP coordinate system usually describes the acre point of pickling of a new tool. The TCP position coordinates can become thus immediate without other transformation the correction of the before specified TCP position coordinates used.

This proceeding leads on the one hand to the fact that measuring only a simple reference crossing point in the work space of the Industrierobo must become ters defined. The measuring device can become thus relative in subject compared with a calibration block constructed. Besides he mōglicht the method rapid and unique starting of the reference of crossover by the tool tip, in order to make a correction of the TCP position coordinates with wear, deflection or the similar tools. This becomes in a simple manner only achieved by the fact that the tool becomes measuring in the TCP coordinate system guided. The origin of the TCP coordinate system, D. h. the working point of the work of things will thus measure the basis coordinates of the reference crossover of the light barrier measuring instrument on that early fixed working point stationary held and it regarding that early fixed acre point of pickling.

< Desc/ Clms PAGE NUMBER 7>

The invention becomes subsequent more near explained on the basis the accompanying designs. Show: Fig 1-perspektivische view of a measuring pre according to invention direction with two itself crossing light barriers; Fig 2-Draufsicht on the measuring device after fig 1; Fig 3-Skizze of an industrial robot with several arms and basis coordinate system as well as axle coordinate systems; Fig 4-Skizze of the misalignment of the operating point of a tool after wear regarding a TCP coordinate system.

The fig 1 shows a measuring device according to invention 1 in perspekti vischer view. The measuring device 1 has a frame 2 with two from each other spaced parallel legs 3a, 3b open on a being of width unit. The measuring device 1 is thus u-shaped. Kel the 3a, 3b is integral 4 connected with an holding plate, with which in measuring device 1 stationary in the work space of the industrial robot can be tiert mon.

In the legs 3a, 3b are diagonal for this aligned light barriers ā, 5b provided, in a reference crossing point R in the Zwi schenraum between the legs 3a, 3b meet. For this in each case a transmitter 6 and a receiver are 7 per light barrier ā, 5b at a front end of a first leg 3a and to rear end of the other kels 3b for the first light barrier ā and/or. at the rear end of the he leg 3a and the front end of the second leg 3b for the second light barrier 5b mounted sten. In this way a Ga becomes

< Desc/ Clms PAGE NUMBER 8>

bellichtschranke provided, which is preferably formed as infra-red light barrier.

The fig 2 shows the measuring device 1 in the plan view. It becomes significant that the light barriers ä, 5b diagonal between the legs 3a and 3b run and in the clearance of the legs 3a, 3b in a reference crossing point R to meet.

A working point TCP of a tool for an industrial robot, with the spielsweise tool tip, will proceed in such a way for measuring the operating point TCP that the working point TCP lies in the reference crossing point R of the measuring device 1. Into this cases with is de Lichtschranken ä, 5b by the tool tip interrupted, so that a switch signal becomes generated.

The measuring procedure becomes in the following more near explained.

The fig 3 shows a sketch of an industrial robot 8. A Indu stringer robot 8 has a basis coordinate system Öo or absolute Cartesian coordinate system stem, which is stationary regarding the foundation of the industrial robot 8 aligned. At the pedestal 9 is a chain of over gel ke 10 connected with one another arms 11. For everyone of these arms 11 an axle coordinate system I 2 3 defined, with that position and Ori is entierung the respective end of the corresponding arm 11 regarding the associated joint 10, with the arm 11 with the preceding arm 11 connected is, describes.

At the end of the chain of arms 11 is a palm 12, is 13 mounted to which the tool.

< Desc/ Clms PAGE NUMBER 9>

For the tool 13 is a TCP coordinate system (9ycp fixed, which has an origin in the working point TCP of the tool. For the tool 13 TCP position coordinates provided, those the position and orientation of the operating point TCP regarding the point of tool basis W at the hand flange 12, become D on the basis of this TCP coordinate system OTCP. h. regarding the fixing point of the tool 13 at the industrial robot 8 defined.

In order the TCP position coordinates in the operation related to the Werkzeugba W of the industrial robot 8 rapid sispunkt and with small computing up wound measures to be able, the tool tip of the tool 13 into the reference crossing point R that to stationary mounted measuring device 1 on the basis of the TCP coordinate system TCP en will according to invention drive. It made thus a Interpola based on the working point TCP tion the Verfahrweges when leading the tool of 13 by the Indu stringer robots 8. The origin of the TCP coordinate system (3p becomes here stationary regarding the fixed TCP position coordinates of the acre of point of pickling TCP held. From the Verfahrweg the direct Verschie can become bung the operating point TCP when wear or bending the tool 13 in the TCP coordinates certain. It becomes thus quasi an en unit deformation of the reference crossover R regarding an origin left chen reference crossing point RTCP certain. Thus is void the emergency whom digkeit to accomplish aufwändige Koordinatentransformationen and only as in a step the reference crossing point R ange needs it will drive.

The fig 4 shows the tool 13 with the TCP coordinate system TCP that its origin in the working point TCP of the tool 13

< Desc/ Clms PAGE NUMBER 10>

has. For the case of the outlined curvature of the tool displaced itself the working point TCP, regarding the before specified origin left chen working point TCPo. The TCP position coordinates are to be corrected around this Verschie bung/\ TCPo= TCP1 - TCPo. Since the control of the robot 8 regarding the TCP coordinate system TCP he follows according to invention, the difference between the original fixed TCP position coordinates TCPo and the attitude of the new operating point TCP, a worn tool becomes 13 immediate determined.